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AIR FORCE HUMAN RESOURCES LABORATORY

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FORMATION FLIGHT TRAINER EVALUATION FOR T-37 UPT

By
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FLYING TRAINING DIVISION
Williams Air Force Base, Arizona 85224

June 1977

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AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

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The present research was conducted to provide a preliminary look at the feasibility of using a general-purpose trainer rather than an aircraft-specific simulator, to provide formation practice for undergraduate pilot training (UPT) students. The results obtained appear to support a conclusion that trainer practice does have positive transfer to aircraft formation flying. A principal finding is that students in this study were influenced more by stage of training than were more advanced students in previous studies using the same equipment.

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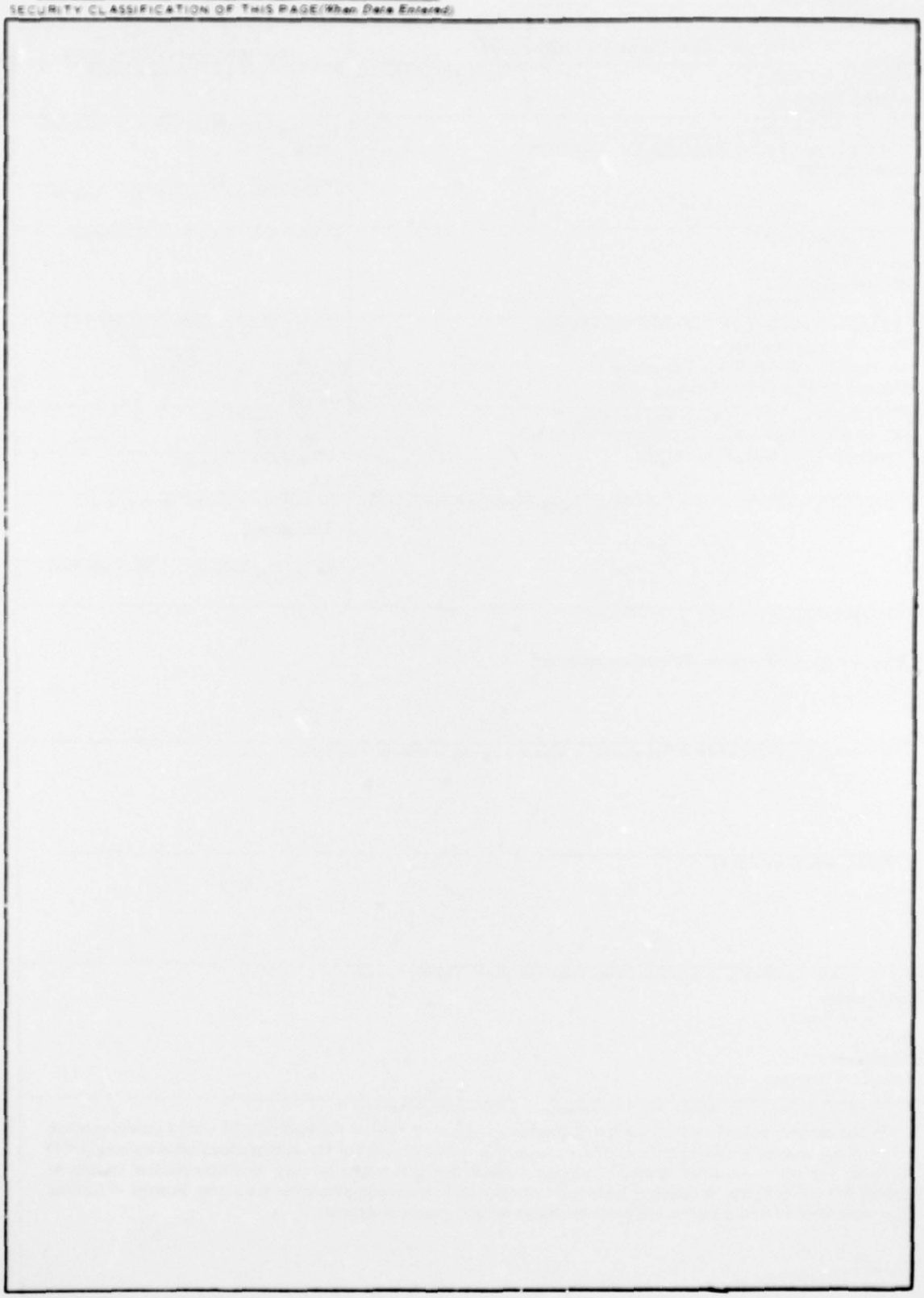

PREFACE

This study was conducted in support of project 1123, Flying Training Development; task 112302, Training Innovations. Dr. William V. Hagin was project scientist; Mr. Gary B. Reid was task scientist and principal investigator.

This study was conducted by the Flying Training Division of the Air Force Human Resources Laboratory (AFSC), in coordination with Headquarters Air Training Command and supported by the 82d Flying Training Wing and 96th Flying Training Squadron of Williams AFB, Arizona.

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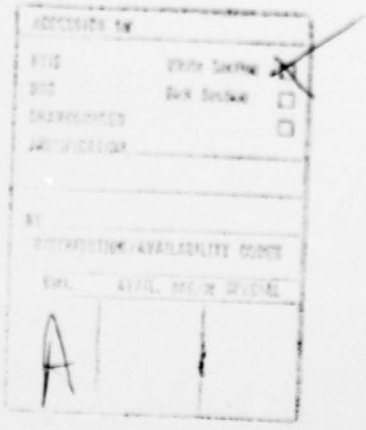

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I. INTRODUCTION

The formation flight trainer (FFT) was developed by the United States Air Force to provide student pilots with minimum sensory cues necessary to simulate the wing component of formation flight. This trainer is designed primarily to provide undergraduate pilot training (UPT) students practice prior to their first aircraft formation ride. When the FFT was designed, nearly all formation practice occurred in the T-38 (the second training aircraft). Only a few demonstration rides were flown in the T-37 (the first training aircraft). The FFT was, therefore, designed as a simple low-fidelity T-38 simulator.

After procurement of the FFT, a UPT syllabus change resulted in a considerable increase in formation practice in the T-37. Even though positive transfer had been demonstrated for the T-38 in previous research (Reid & Cyrus, 1974) this syllabus change necessitated an investigation into the feasibility of changing to a T-37 simulator, or to a general-purpose formation trainer (not having characteristics representative of any particular airplane). The current research was undertaken as a preliminary investigation into the transfer effectiveness of the general-purpose type of formation trainer.

II. METHOD

Subjects

Sixty-six students were selected for this study from UPT classes 75-05 and 75-07 at Williams Air Force Base, Arizona. The classes were divided into three study groups for the T-37 formation phase of UPT. At this stage of training, the students had completed approximately 80 hours of flying training in the T-37 aircraft. The sample was restricted to United States citizens without previous flying expérience. Subsequent to being selected for the study, and prior to the end of the study, five of the students were eliminated from UPT for reasons unrelated to the study. Therefore, a total of 61 subjects participated in the study.

Instructor Pilots

Five instructor pilots (IP) from the 96th Flying Training Squadron were instructors in the FFT. These instructors were selected according to their willingness to take on an additional duty and their supervisors' approval of their reduced availability for regular flying duty. They were trained in FFT operations but were allowed to use any techniques that they had previously developed for aircraft instruction.

Equipment

The FFT is a simulation system which provides a realistic two-aircraft formation flight situation (Figure 1). The trainer provides the student with a wide-angle, projected television picture of a lead aircraft that is continuously variable in range, relative bearing and relative altitude. The picture of the lead aircraft can be commanded by an IP to perform standard maneuvers while the student attempts to maintain position in formation by control actions from his own simulated aircraft cockpit. A detailed description of the FFT can be found in Wood, Hagin, O'Connor, and Myers, 1972. For this study, the FFT was modified to provide the student with a visual representation of the T-37, but the student's cockpit and controls remained T-38. The computer program was modified to make the trainer "fly" less like a T-38, with T-37 control feel and aircraft dynamics as a goal. The model airplane was changed so that the visual image projected for the student was a T-37 to provide the same visual references as he would use when he transferred to the actual aircraft.

Procedures

The same three groups, complete random design (Table 1) as used in the previous research (Reid & Cyrus, 1974) was used for this experiment. Treatments were randomly assigned to the groups as follows: Group A was the FFT-trained or experimental group; Group B was a limited training group; and Group C was an aircraft or UPT-syllabus-trained group.

Five 50-minute training sorties, in a block prior to aircraft practice, were used. Each of the five FFT sorties was instructed by a different IP in an effort to control for differences in IP experience or ability.

All three groups received at least one aircraft orientation sortie before they received the evaluation check ride. Group A flew one sortie in the T-37 after completing the five FFT sorties. The purpose of this sortie was to allow the student to

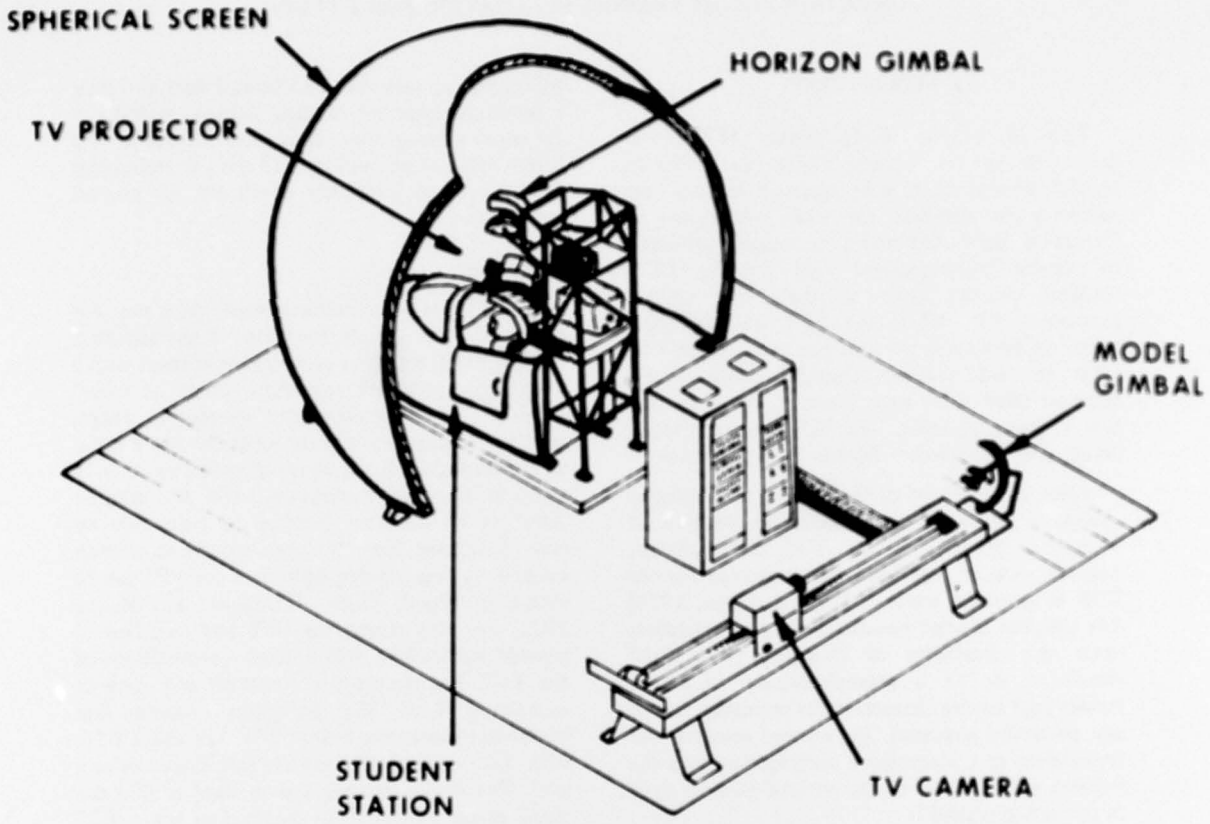

Figure 1. **Formation flight trainer.**

Table 1. **Number and Type of Flying Sorties by Treatment Group**

Groups	Sorties			
	FFT	Aircraft Orientation FS1-01	Aircraft Training	Aircraft Study Data Ride
A. FFT	5	1	0	1
B. Limited Training	0	1	0	1
C. UPT Syllabus	0	1	2	1

put what he had learned in the simulated flight environment into the airplane context. Either a sixth trainer IP, or the trainer IP who had instructed the first FFT sortie, flew this aircraft sortie with the student. All maneuvers were demonstrated and differences between the FFT and T-37 were emphasized.

Group B received only an aircraft orientation ride. All maneuvers were demonstrated and explained during the orientation ride. Thus, on the following day when a student was asked to attempt a maneuver on a data checkride, he at least had been shown the desired performance, even though he had not had an opportunity to practice.

Each Group C student flew the first three aircraft sorties as if they were not part of a study. The first sortie was essentially the same as the one flown by Group A and B, except it was flown with the normally assigned IPs.

IPs were allowed to use any sequence of maneuvers and instructional technique they desired, as long as the students were trained on *fingertip, crossunder, turning rejoin, and wingwork* (fingertip at 15° to 30° bank). The day following the aircraft orientation ride, each student flew a T-37 check ride and his ability to fly the airplane through the five basic maneuvers was evaluated.

Performance Assessment

All groups were given a data checkride. The checkride profile was a modified version of the check ride used for the previous T-38 FFT study. The modification was to remove steep bank turns (60° to 90° bank), echelon turns and straight-ahead rejoins since these maneuvers are not part of the normal T-37 syllabus. The order of the six remaining basic formation maneuvers was precisely defined to prevent students from having different amounts of practice prior to evaluation. When operational restrictions prohibited the flying of the profile as defined, the IP took control of the aircraft until the profile could be executed. Check IPs were asked not to instruct on any maneuver until after check ride completion. The lead aircraft was always flown by an IP rather than a student to insure that lead was as stable as possible for students flying wing. The data check ride was not part of the normal training program and was inserted at the appropriate time according to which study group the student was assigned.

Maneuver grades were assigned by IPs using a 12-point grading scale developed by expanding the existing 4-point UPT grading scale. The 12-point scale was defined as follows:

1. Instructor had to assume control almost immediately to avoid collision.

2. Instructor eventually had to assume control as performance deteriorated.

3. Instructor never assumed control; however, performance was still unsatisfactory.

4. Performance very rough; however, instructor found that verbal assistance corrected problem.

5. Performance rough–minimal verbal assistance would correct problem.

6. Performance rough; however, no verbal assistance necessary–practice should improve performance.

7. Performance somewhat smoother than an F student; however, becomes rough after short time.

8. Performance somewhat smooth but *continuously passes through desired position.*

9. Performance smooth, deviations from desired position last several seconds.

10. Performance very smooth; after deviations, aircraft returned to position quickly.

11. Performance very smooth; deviations are small and aggressively corrected.

12. No deviations noted: perfect position maintained.

The grade assigned each maneuver was obtained by averaging two attempts at each one (once each direction or on each side).

The grade for each student's data check ride was derived by multiplying each maneuver grade by a weight extracted from the operational ATC Checkrides. These weights account for the varying difficulty and importance of the maneuvers to the entire operational task. The nine maneuver grades were then summed and transformed to standard scores with a sigma of ten and a $\bar{X}$ of 50. (Guilford, 1965). The equation used was:

$$T = 10\left(\frac{X_o - \bar{X}_o}{\sigma_o}\right) + 50$$

$\bar{X}_o$ = Mean grade assigned by a particular check pilot.

σ_o = Standard deviation of grades assigned by a particular check pilot.

X_o = Observed grade for one student by a particualr check pilot.

III. RESULTS

The data check ride grades for the three groups were analyzed by a oneway analysis of variance (Table 2). The differences between the groups were statistically significant $F(2,58) = 20.3$, $p < .05$. Calculation of an Omega Square indicates that the treatment effect accounted for 38.75% of the variance.

Table 2. **Analysis of Variance: Aircraft Performance Scores**

Source	DF	MS	F
Between Groups	2	1,112.06	20.3*
Within Groups	58	54.77	
Total	60		

*$p < .05$.

Subsequent to the analysis of variance, an "a posteriori-test" (Tukey's HSD), was performed to ascertain statistical significance for between-group comparisons (Kirk, 1968). As indicated in Table 3, the UPT syllabus-trained group (Group C) scored higher than both the limited training group (Group B), and the FFT-trained group (Group A). The mean for the FFT-trained group was higher than the mean for the limited training group, but the difference was not found to be significant at the .05 level (the difference is significant for $p < .16$).

Table 3. **Differences Among Means of Performance Scores**

Groups		$\bar{x}_B$	$\bar{x}_A$	$\bar{x}_C$
$\bar{X}_B$	(Limited Training) = 44.37	–	3.33	14.36*
$\bar{X}_A$	(FFT) = 47.7	–	–	11.03*
$\bar{X}_C$	(UPT Syllabus) = 58.73	–	–	–

Note. – N = 61.
*$p < .05$.

IV. DISCUSSION

The present study was conducted to provide a preliminary look at the feasibility of using a general-purpose trainer rather than an aircraft-specific simulator to provide formation practice for UPT students.

The desirability of doing the study and the structure of it were precipitated by events in operational undergraduate pilot training. For example, the reason for such a large jump to use a degraded T-38 trainer for T-37 training was directed toward the operational question "If Air Training Command purchased T-38 formation trainers, could they also be used in the T-37 phase of UPT?" This jump, unfortunately, is a source of confounding in comparing the previous T-38 study with the current study because of the difference in the experience between T-37 and T-38 students. On the other hand, these two studies do provide the ends of a fidelity/student continuum, and the direction of the studies to provide the data points in between can be responsive to operational Air Force needs.

The results obtained in this study appear to support the premise that FFT training does have positive transfer to aircraft formation flying. The inability of the FFT-trained students to approach the performance of aircraft-trained students can be explained by the experience level of the students. This is strongly indicated by comparing the Omega Square for the T-38 and T-37 studies. This value is a measure of how much of the variance in the data is attributable to the treatment variable. In these studies, the treatment variable is training (aircraft and FFT). In Parts I and II, of the T-38 study, 15.7% and 17.5% respectively, of the variance was accounted for by training; while in the T-37 study, 38.76% of the variance was accounted for by training. It follows then that the T-37 students were much more influenced by training than the students in the T-38 study. While the FFT-trained students' performance was not statistically

different ($p < .05$) than the performance of the minimally trained group, their mean score was higher. Therefore, the direction of all the differences in this study correspond to the findings of the T-38 study, and most of the differences in magnitude appear to be related to stage of training. Conclusive evidence of this hypothesis awaits follow-on studies using varying amounts of FFT training for T-37 students.

A clear understanding of the role of the general-purpose FFT versus the aircraft-specific simulator must also await additional research. In addition to the studies varying the amount of FFT training for T-37 students, similar studies must be conducted in the T-38 phase of training, using degraded FFT performance.

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